Hemlock Woolly Adelgid: Predictive Modeling of Extent and Spread

Noelle Chaine, Bari Greenfeld, Natalie Koscal, Miranda Reid, Cathy Fahey

Background

Across the Appalachians, stands of Eastern hemlock are under siege. The hemlock woolly adelgid (*Adelges tsugae*), an invasive sap-sucking insect, is causing widespread mortality of Eastern hemlock in affected areas from Georgia to Massachusetts (Pennsylvania). Approximately 50% of the Eastern hemlock population has been impacted by adelgid infestation. With the capacity to kill host trees in only 3-6 years, hemlock woolly adelgid (HWA) has caused widespread mortality since being introduced to New York State in 1985 (New York). Eastern hemlock are an important component of the northern hardwood forest, providing ecosystem services that range from stream bank erosion control to critical habitat for wildlife (Orwig and Foster 1998; Tingley et. al. 2002). Mitigating the effect of HWA is a substantial conservation concern - requiring earlier detection of spread, efficient use of volunteer efforts, protection of sensitive areas, and targeted implementation of biological control.

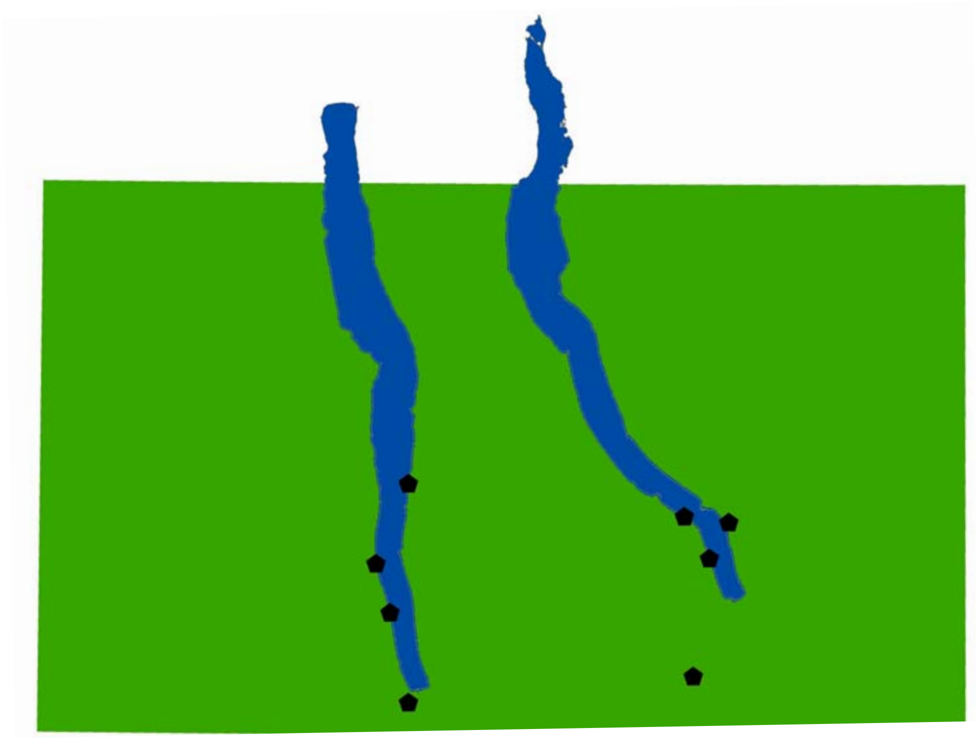
Objective

Create a predictive model for landscape areas most susceptible to hemlock woolly adelgid infestation and spread.

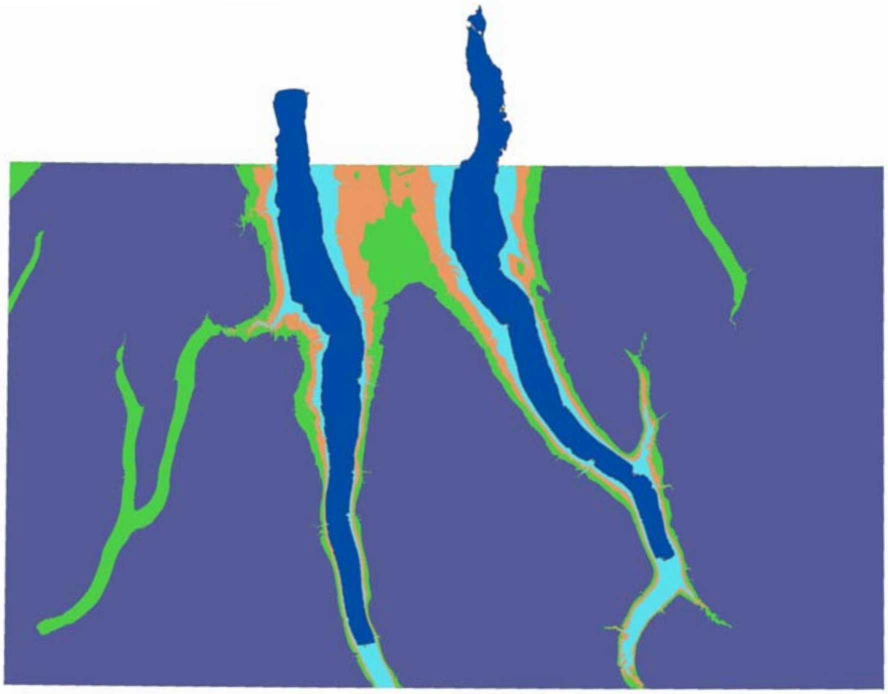
Methods

In ArcGIS, a ranking system was applied to various landscape characteristics based on known locations of HWA infestation (Orwig et. al. 2002). Because the adelgid's extent is primarily controlled by temperature, we chose topographical aspects of the landscape to help create a predictive model for HWA extent and spread (Evans and Gregoire 2007). Data were available for 6 polygons of HWA infestation in the Cayuga and Seneca Lake regions. The slope, aspect, elevation, and distance to lakes and streams were determined for each of the polygons. From this information, the best predictors of actual polygon location were used to create a model of the most suitable conditions for infestation. By overlaying data layers as well as using weighting and map algebra, we created a final binary product of likely and unlikely locations for HWA.

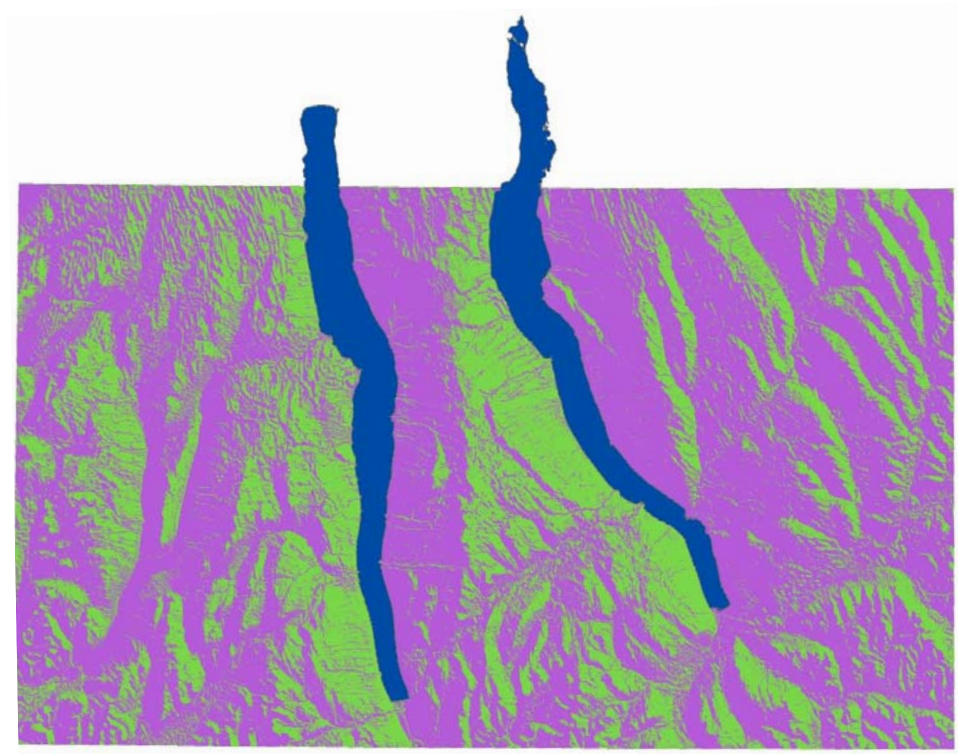
Results



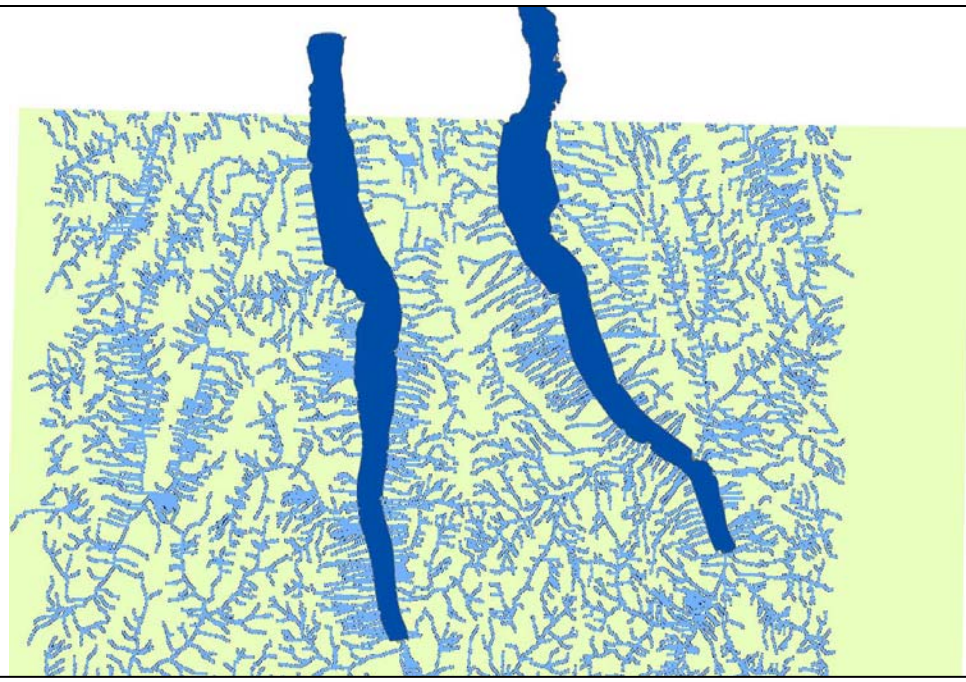
Locations of polygons of HWA infestation relative to Cayuga and Seneca Lakes.



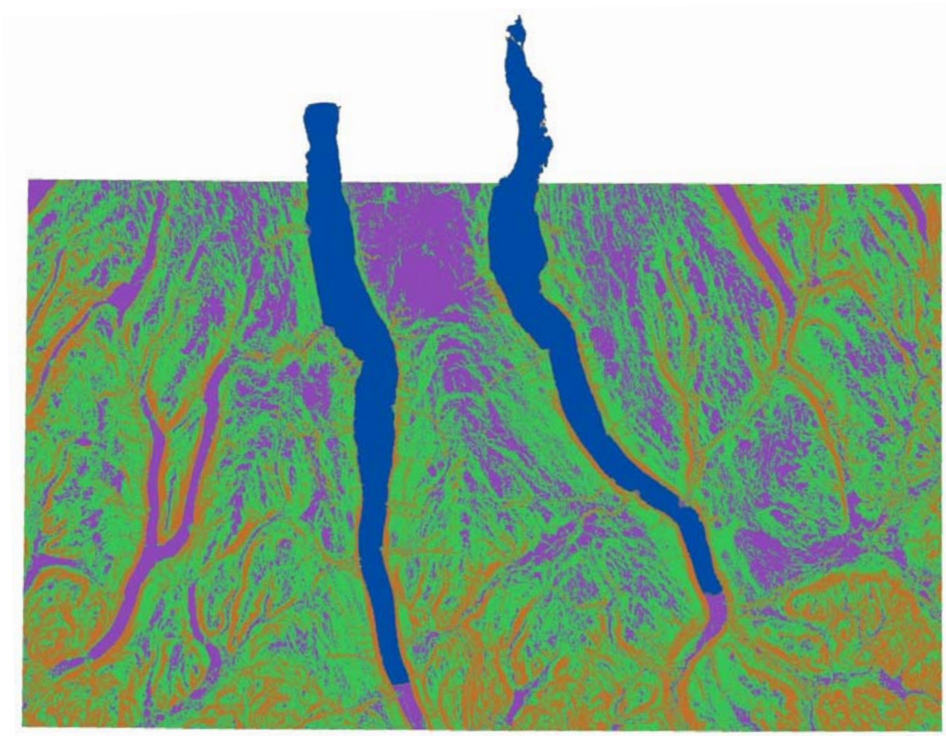
GIS map of elevation. High elevations (purple) were given a weight of 0. Moderately high elevations (green) were given a weight of 1. Moderately low elevations (orange) were given a weight of 2. Low elevations (light blue) were given a weight of 3.



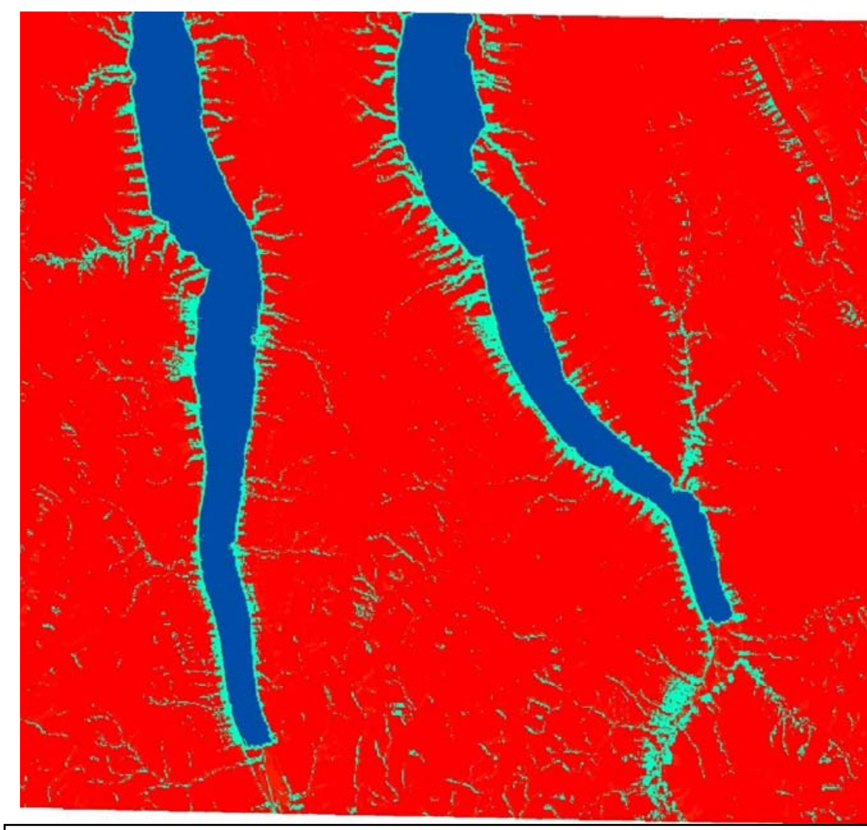
GIS map of aspect, where North, Northeast, and East aspect slopes (green) were given a weighting of 1 and all other aspects (purple) were given a weight of 0.



GIS map of distance to streams. Within 120 meters of streams (light blue) was given a weight of 2. Within 180 meters of streams (black) was given a weight of 3.



GIS map of slope. Moderate slopes (orange) were given a weight of 2. Low and high slopes (green) were given a weight of 1. Flat slopes (purple) were given a weight of 0.



GIS model of predicted locations for infestation by HWA, where most likely locations are light blue and less likely locations are red.

References

Evans, M. and T. G. Gregoire. (2007) A geographically variable model of hemlock woolly adelgid spread. Biological Invasions 9:369–382

New York Department of Environmental Conservation website

Orwig, David A. and David R. Foster (1998), Forest Response to the Introduced Hemlock Woolly Adelgid in Southern New England, USA *Journal of the Torrey Botanical Society*, Vol. 125, No. 1 60-73.

Orwig, David A., David R. Foster and David L. Mause (2002) Landscape patterns of hemlock decline in New England due to the introduced hemlock woolly adelgid. Journal of Biogeography, 29, 1475–1487.

Pennsylvania Department of Conservation and Natural Resources website

Tingley, Morgan W., David A. Orwig, Rebecca Field, and Glenn Motzkin (2002). Avian response to removal of a forest dominant: consequences of hemlock woolly adelgid infestations. Journal of Biogeography, 29, 1505–1516.